agri-fax
Diseases, Insects, Pests
Alberta AGRICULTURE

92-00024/

July, 1991

Agdex 640-7

Herbicide Resistance

Introduction

Recently, Prairie producer's have been challenged by another production concern – herbicide resistance. The number of herbicide resistant weeds and the area presently infested by them has increased. In 1989, seven sites were confirmed to have triallate (Avadex BW) resistant wild oats in Alberta. By 1990, this number had more than doubled. If producers do not pay close attention to the problem the situation will get worse. Producers applying herbicides should have a knowledge of herbicide resistance and how to prevent it.

How resistance develops

Weed populations contain a very small number of individual plants that are naturally able to withstand a particular herbicide (or herbicide group) which is registered to control the weed. This naturally occurring resistance is not due to weather conditions or application technique but is an inherent characteristic of the genetic makeup of the resistant plants.

Because of their low frequency of occurrence, these resistant plants go undetected. The continual use of the same herbicide (or herbicide group) year after year allows them to set seed and multiply. Furthermore, by removing the susceptible weeds, there is more opportunity for the resistant strain to flourish.

It is important therefore to know the herbicide groups so that herbicides with different mechanisms of action can be selected as part of the strategy in preventing a build up of resistant weeds. A herbicide group includes those products that kill a weed in the same way, also known as the "mechanism of action". For example, although Glean and Muster have differences in weed spectrum and crop tolerance, both herbicides kill broadleaf weeds by inhibiting the same enzyme; therefore, they belong to the same herbicide group.

Table 1: Herbicide groups based on their mechanism of action

Group 1	Excel, Fusilade II, Hoe-Grass 284, Hoe-Grass II, Laser*, Poast, Triumph Plus*, Achieve**, Assure**, Puma**, Select**.
Group 2	Ally, Assert, Amber**, Glean, Muster, Refine, Triumph Plus*.
Group 3	Advance 10G, Edge, Fortress*, Rival, Treflan, Triflurex.
Group 4	2,4-D, MCPA, Banvel, Blagal*, Buctril M*, Diphenoprop*, Dyvel*, Estaprop*, Kil-Mor*, Lontrel, Mecoturf, Target*, Tordon 202C*, Triumph Plus*, Tropotox Plus*.
Group 5	Bladex L, Blagal*, Lexone, Sencor.
Group 6	Buctril M*, Hoe-Grass II*, Laser*, Pardner.
Group 7	Afolan F, Lorox.
Other herbicides	The herbicides Avadex BW, Avenge 280C, Carbyne, Eptam, Mataven, Stampede, TCA and Basagran are each in a group of their own.

Source: Heap and Morrison.
*Products contain more than one active ingredient and therefore may appear in more than one group.
**Products not registered of May 1991. New herbicides do not necessarily have a unique mechanism of action and may fall within the groups listed above.

Note: Herbicides that have the same mechanism of action do NOT necessarily control the same weed spectrum or have the same degree of crop safety. For example , Assert and Ally have the same mechanism of action, however, Assert controls wild oats; Ally does not. Read and follow label instructions.

Copies of this and related publications may be obtained from the Print Media Branch, Alberta Agriculture, 7000 - 113 Street, Edmonton, Alberta T6H 5T6 or Alberta Agriculture's District Offices.

Resistant grassy weeds

Trifluralin/ethalfluralin (Edge)– resistant green foxtail (wild millet)

In Western Canada, the first documented field-scale infestation of resistant weeds was discovered in southern Manitoba, where researchers detected a population of green foxtail resistant to trifluralin. Products containing trifluralin (Treflan, Rival, Triflurex, Advance, Fortress) and Edge belong to the same group of herbicides. Trifluralin-resistant green foxtail has appeared in response to repeated applications of trifluralin. It occurs most often when the herbicide had been applied to all crops included in the rotation. Because trifluralin is a residual herbicide, it can carryover sufficiently after a high rate application in canola to control susceptible green foxtail in a cereal crop grown in the following year. Thus, resistant green foxtail plants escape the trifluralin treatment and reproduce every year, including years when cereals are grown without using trifluralin. Table 2 presents the history of two fields in which the development of trifluralin resistant foxtail has occurred. Trifluralin-resistant foxtail is also resistant to Edge, which is in the same group of herbicides and therefore has a similar mechanisms of action. Producers can use other products such as Hoe-grass 2, Fusilaid, Laser, Poast, Triumph Plus, TCA and Stampede CM in their rotations to control green foxtail and to combat further development of resistance as part of their herbicide rotation program.

Table 2. Herbicide history of two fields having trifluralin/edge resistant green foxtail

	Field 1		Field 2	
Year	Crop	Trifluralin (500 g/LEC) (L/ac)	Crop	Trifluralin (Granular 5%) (kg/ac)
1988	Canola	1.05	Lentils	11.3
1987	Wheat	0.45	Wheat	0
1986	Wheat	0	Canola	11.3
1985	Canola	1.05	Wheat	0
1984	Wheat	0.45	Flax	11.3
1983	Wheat	0	Wheat	0
1982	Canola	1.05	Lentils	11.3
1981	Wheat	0.45	Wheat	0
1980	Wheat	0	Lentils	11.3

Source: Heap and Morrison

Herbicide-resistant wild oats

Wild oats remains the most costly weed to contend with. The occurrence of resistant wild oats may in fact be the biggest challenge facing producers in the 1990s.

Wild oats resistant to Hoe-Grass 284, Poast, Hoe-Grass II, Excel, Fusilade, Fusilade II, Laser and Triumph Plus, have been identified in Saskatchewan and Manitoba. While these products contain different active ingredients, they attack the same enzyme system in the plant. The field histories listed in Table 3 indicate that herbicides from the same herbicide group were used continuously for nine years with no rotation to other chemical with different mechanisms of action. The repeated use of Hoe-Grass and Poast in the early 1980s undoubtedly contributed to the development of the problem. Continued use of newer herbicides in this group such as Triumph Plus, Fusilade II or Excel would further encourage the increase of resistance plants in those fields. Wild oat herbicides that are not in the same group, could provide control of wild oats in cereal crops, they include Avenge, Mataven, Assert, Avadex and Fortress.

Table 3. History of two fields having herbicide resistant wild oats.

	Field 1		Field 2	
Year	Crop	Product	Crop	Product
1990	Wheat	Truimph Plus	Wheat	Hoe-Grass
1989	Flax	Poast	Canola	Poast
1988	Barley	Hoe-Grass	Wheat	Hoe-Grass
1987	Flax	Poast	Wheat	Hoe-Grass
1986	Wheat	Hoe-Grass	Wheat	Hoe-Grass
1985	Barley	Hoe-Grass	Canola	Poast
1984	Wheat	Hoe-Grass	Wheat	Hoe-Grass
1983	Barley	Hoe-Grass	Wheat	Hoe-Grass
1982	Wheat	Hoe-Grass	Wheat	Hoe-Grass

Source: Heap and Morrison

Unfortunately, herbicide resistance in wild oats is not restricted to the post emergent herbicides. Wild oat resistance to Avadex BW has been reported in Saskatchewan and Alberta. The field histories obtained from the confirmed Avadex BW resistant wild oat sites indicate 10 years of continuous use has created the problem. This is the first documented incidence of cross resistance. The Avadex BW resistant wild oat is also completely resistant to Avenge, a herbicide that has a different mechanism of action and belongs to a different group of herbicides. Options that remain available for control of Avadex BW resistant wild oats are Mataven, Hoe-Grass 284, Hoe-Grass II, Assert, Poast, Fusilade, Excel and Triumph Plus.

Resistant broadleaf weeds

Sulfonylurea – resistant broadleaf weeds

A number of broadleaf herbicides such as Glean, Ally, Refine and Muster all belong to the sulfonylurea (SU) group of herbicides. Sulfonylurea – resistant chickweed, kochia and Russian thistle have been identified in Alberta and Saskatchewan. Glean, the first SU herbicide registered for use in cereals, is a highly residual herbi-

cide which can carryover for several years. This residue kills off the susceptible weed seedlings over a long period of time. The soil reservoir of susceptible seedlings becomes depleted and is replaced by the seed from resistant plants. Field histories from two of the SU resistant chickweed sites indicates that it took only four years to develop a SU resistant biotype (Table 4). Sencor, Lexone, Lorox, Afolan F and Blagal will still control the SU resistant chickweed. These products can also be used in a herbicide rotation program to avoid the build up of SU resistant chickweed.

Figure 1. SU resistant chickweed.

Field histories indicate that sufficient carryover from high rates of Glean in wheat effectively controlled Kochia and Russian thistle into the summerfallow year, particularly if conditions were dry and led to the appearance of SU resistant strains. Thus, the resistant biotypes were selected for and reproduced every year, including those years where wheat was produced without using any Glean.

Table 4. Histories of two fields infested with Glean resistant chickweed

	Field 1		Field 2	
Year	Crop	Glean g/ac	Crop	Glean g/ac
1988	Wheat	15	Barley	0
1987	Barley	10	Canola	0
1986	Wheat	10	Wheat	12
1985	Barley	12	Wheat	12
1984			Field Peas	0
1983			Barley	12
1982			Barley	12

Researchers in Manitoba have discovered a patch of wild mustard that is resistant to a mixture of MCPA, Mecoprop and dicamba. Again, it was the continuous use of this product in wheat for an eight-year period that produced a resistant wild mustard population.

How to identify resistance

It is critical to investigate suspicious situations as soon as a problem is recognized. Rule out other factors that might have affected herbicide performance including misapplication, spray misses, unfavorable weather conditions, herbicide application at an improper leaf stage and weed flushes after application. If resistance remains a likely possibility, check for the following:

- Are other weeds listed on the product label controlled satisfactorily?
- Is herbicide failure patchy with no reasonable explanation?
- Did the same herbicide or herbicide group fail in this area of the field in the previous year?
- Do weeds show herbicide injury symptoms such as root pruning by trifluralin?
- Do field histories indicate extensive use of the same herbicide (or herbicide group) year after year?

If one or more of these apply, it is possible that the weeds are resistant. If resistance is suspected, contact either your local extension office, weed specialist or the appropriate chemical company to follow up on the problem.

How to minimize the development of resistance

Follow the guidelines below to delay the appearance of resistance.

Rotate herbicides.

Using the same herbicide year after year may cause resistance to develop. To avoid resistance, herbicides must be rotated. It is important not only to use a different herbicide but to use one from a different herbicide group with

a different mechanism of action. If herbicide rotation is not practised, resistant plant populations will continue to increase.

Table 1 groups herbicides with the same mechanism of action. Successive use of products from the same group is not a true herbicide rotation.

Use herbicides only when needed.

Use herbicides as part of an integrated control program and not as the sole method of weed control.

Timely cultivation and cultural control practices that favour strong crop competition and can effectively reduce weed populations.

Gearing a weed control program to a particular weed in a field using the same herbicide can result in the development of resistance. Tolerate weeds in a crop if they are below economic damage levels.

Keep records of herbicide applications.

Records are needed for making sensible decisions on herbicide rotation and evaluating the probability of resistance developing. Records should consist of the field location/name, year, crop, herbicides and rates applied, weed infestations present at spraying and the control produced by the herbicide(s).

The more detailed the records, including environmental conditions at time of spraying, date and time of spraying and spray volume per acre, the better the chance of accurately interpreting the probable cause of weed control failures. An example of a pesticide application record sheet can be found in the provincial crop protection guide.

Use of tank mixes.

In a few cases, use of a tank mix may delay the appearance of resistant to weeds. Using a tank mix for this purpose is only worthwhile in combatting resistance if the components of the tank mix control the same weed by different mechanisms.

For instance, either Refine or MCPA will control lamb's-quarter – each killing the plant in a different way. Using the tank mix of Refine and MCPA, rather than using one product on its own, means there is less chance of lamb's-quarters developing herbicide resistance.

Managing resistant weeds

When herbicide resistant weeds become abundant in a field, alternative methods of control must be used. It is impractical to assume that resistant weeds can be eradicated. Even after many years, some resistant weeds will persist in the field and continue to pose a problem.

Care must be taken to ensure resistant weeds are not spread by harvesting equipment, untarped trucks, field equipment or contaminated straw, throughout the field or to other fields. It is also important to ensure that seed is not contaminated with resistant weeds.

In areas where resistant weeds are already a problem, it is important to rely on tillage, cultural controls, and herbicides from other groups in an agronomically sound, integrated weed control program.

Prepared by:

Denise Maurice, Supervisor
Weed Research and Technology Development
Alberta Agriculture

Doug Billett
Weed Control Specialist
Saskatchewan Agriculture and Food

1991 07 5M